Keep inhabitants from the danger of buildings damaged by a major earthquake

Postearthquake Quick Inspection of Damaged Buildings

Japan has many experiences of building damage caused by earthquakes and it has managed to recover from such disasters each time. Buildings hit by earthquakes can cause further injuries and death to inhabitants if left unchecked and unstable. Therefore, after a big earthquake, activities such as rescue work, first aid and fire fighting are necessary, but also a quick inspection of the damaged zone is important. This pamphlet introduces a summary of the quick inspection system of damaged buildings in Japan.

Japan Council for Quick Inspection of Earthquake Damaged Buildings

What is the postearthquake quick inspection of damaged buildings ?

The aim of the postearthquake quick inspection of damaged buildings is to prevent secondary disasters by inspecting the buildings hit by major earthquakes and evaluating the risks of building collapse, fall of exterior walls and window glass, the overturn of building equipment and so on that may be caused by aftershocks. Post-evaluation placards posted on damaged buildings inform not only inhabitants but also passersby of the risks. It is said that this placard posting system relieves the anxiety of inhabitants, because architects and building engineers actually inspect each building.

『 **Post-evaluation placards** 』

Who is responsible for the safety management of damaged buildings ?

Generally owners and managers are responsible for keeping buildings safe. This is also the case at the time of a building disaster due to an earthquake; they must keep their buildings as safe as possible by themselves. But in reality it may be impossible to keep their buildings safe by themselves when a major building disaster occurs.

Damaged buildings along the road or very close to other buildings sometimes injure not only inhabitants but also passersby.

On the grounds of such factors, it is important that the public sector evaluates the risk of damaged buildings immediately as part of its emergency post-disaster measures in order to keep residents safe.

Who evaluates the risk of damaged buildings ?

Essentially public servants should take on the role of evaluating the risk of damaged buildings. But in such cases where a major earthquake such as the "Great Hanshin-Awaji Earthquake" strikes, it is impossible to expect only public servants to manage everything. The disaster area would expand and the number of damaged buildings would be enormous. In this case, it is necessary that architects and building engineers from the private sector volunteer to evaluate the risk, and the public sector organizes seminars to train inspectors and registers them as volunteers as preparedness for the case.

The number of risk inspectors in Japan

There are approx. 95,100 registered risk inspectors in Japan. It is equivalent to 0.08% of the total population of Japan.

Outline and role of the quick inspection of damaged buildings

The postearthquake quick inspection of damaged buildings is a system to prevent secondary disaster related to buildings hit by earthquakes, with the voluntary cooperation of judges in the private sector. This system is to evaluate neither the asset value nor the possible use of the damaged buildings into the future. Here we should take note of the meaning of "quick". There are two meanings, "emergency" and "provisionally". Many damaged buildings must be evaluated in a very short time soon after an earthquake strikes. Results obtained from a longer evaluation period sometimes differ from ones from a short evaluation period because of limited inspection items. So we should always inform inhabitants of this possibility. This established quick inspection system in case of disaster plays a very important role in assuring the immediate safety of the inhabitants after earthquakes.

Leaflet for Dissemination

Procedures of the quick inspection of damaged buildings.

Inspectors inspect all kind of damaged buildings, suck as wooden structures, steel structures, reinforced and steel reinforced concrete structures, according to the list of inspection procedures.
They initially inspect the exterior appearances of damaged buildings, and if necessary and upon the owner's consent, the interior also. They also inspect the buildings from the two points of view: the risk of building collapse due to aftershocks (inspection of damaged columns and any leaning of the building) and the risk of fall and overturn of building parts (inspection of roof tiles, window glass and exterior walls).
Then the entire building is given the evaluation result of its most dangerous part. Inspectors then stick placards on the damaged buildings, which indicate "Unsafe (red)", "Limited Entry (yellow)" and "Inspected (green)". The placards provide information regarding the risk of damaged buildings to the inhabitants and passersby.


Inspectors

◎ The visual risk assessment

First and foremost, Inspectors must ensure their own safety when inspecting each damaged building. They must not come too close to obviously dangerous buildings even if they want to inspect them. In such cases they should make a quick visual assessment and indicate "Unsafe (red)" without a detailed inspection.


The visual risk assessment

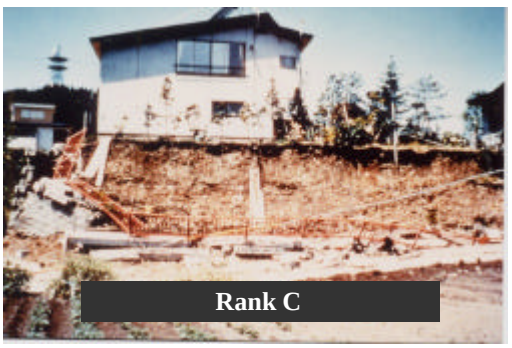

The visual risk assessment


The visual risk assessment

◎ The risk evaluation of adjacent buildings and surrounding ground conditions

Even a building may not immediately appear dangerous, if its surroundings and/or the site where the building is situated are deemed dangerous, the building is classified as unsafe. Thus inspectors inspect not only damaged buildings but also the possibility of the collapse of the unstable neighboring buildings, surrounding slopes and cliffs.


Rank C

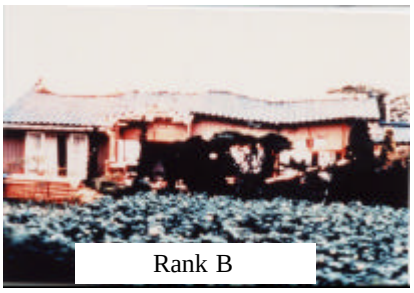

Rank C

◎ The risk evaluation of building frames

Inspectors inspect building frames to observe whether they will be able to resist aftershocks or not, according to the major point of view based on each structural type.

○ Wooden structures

As for wooden structures, the differential settlement, foundation damage, and slant of the first floor, damage of exterior structural wall, and corrosion or any termite damage of groundsills and columns should be inspected.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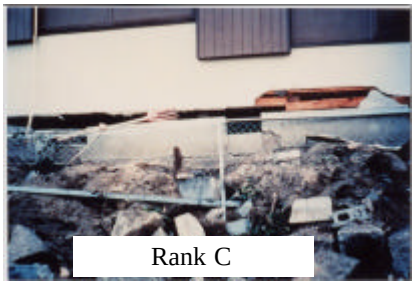
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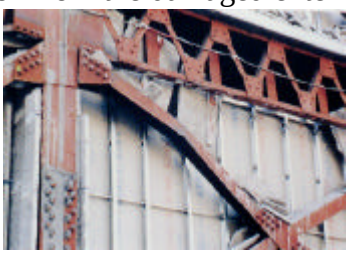
Rank C

○ Steel structures

Steel structures require inspectors to inspect differential settlement, building slant, buckling of members, fracture of bracings and beam-column joints, and damage and rust of column bases. If the slant angle of each floor is different or the columns of steel structure are invisible, inspectors will evaluate the risk from the damaged external structure.

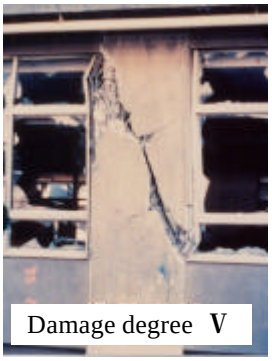


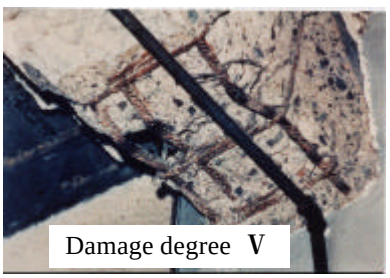
○ Reinforced concrete structures and steel reinforced concrete structures

Reinforced concrete structures and steel reinforced concrete structures require inspectors to inspect the columns with the third damage degree and/or worse, and also the rate of columns which have sustained fourth/fifth degree damage to the total number of columns on the most severely damaged floor.


Damage degree III

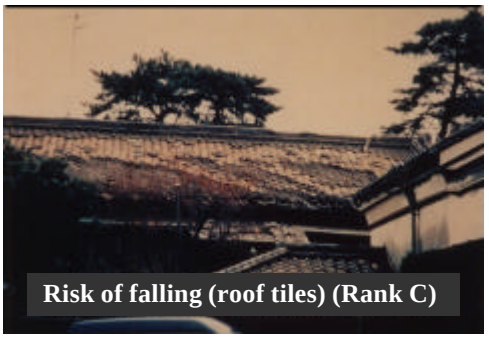

Damage degree IV


Damage degree V


Damage degree V

◎ The risk evaluation of non-structural parts

Inspectors are required to inspect the risk of falling and overturning of roof tiles, window glass, facing materials, outdoor stairs, outdoor signboards, air conditioning facilities, concrete block walls and vending machines, because these non-structural parts and facilities have the potential to hurt residents and pedestrians.



Risk of falling (roof tiles) (Rank C)

Risk of falling (air conditioning facilities) (Rank C)

Risk of overturning (vending machines) (Rank C)

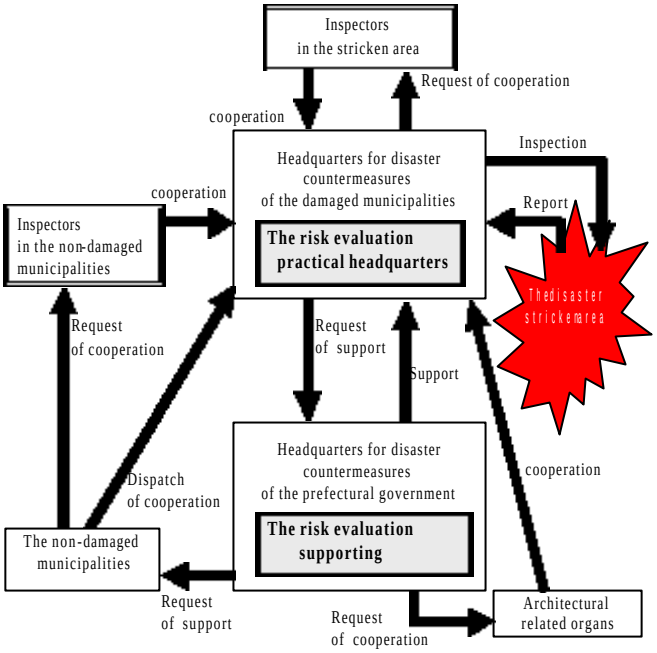
☆ Final evaluation result

Inspectors decide the final evaluation result by the most dangerous risk evaluation. They also have to write specific details to inform the inhabitants in the remark column on the placards.

For practical evaluation activities

○ Establishment of a practical evaluation system

The public sector has to grasp the situation of damaged buildings within its jurisdiction to decide how to implement the quick inspection activities. It is important that the quick inspection system is defined in regional disaster prevention plans and the number of damaged buildings is estimated in advance through simulation.



An example of the Quick inspection system

○ Establishment of a support system

Cooperation between the disaster stricken municipal and prefectural governments is important for the implementation of the postearthquake quick inspection. When a major earthquake occurs, a number of stricken municipalities may request the risk evaluation.
Governments of damaged prefectures will have to establish cooperative systems with other non-damaged prefectural governments. A support system to cover wider areas should be planned and prepared in advance.

○ Training and quality improvement of inspectors

The public sector must educate and train inspectors and make a conscious effort to improve their evaluation techniques and awareness of disaster prevention. It is also essential for them to train evaluation coordinators who organize and supervise the inspection activities.

○ Public relations

It is important that residents know enough about the purpose of the quick inspection system to ensure its effectiveness. Also, for preventing unexpected troubles with occupancy, it is important to explain that this system is not for the evaluation of any building's asset value or possibility of continued use.

From secondary disaster prevention to reconstruction & restoration

After the quick inspection, it is necessary to inspect the degree of damage in detail and to check the necessity of repair or reconstruction of the buildings. The quick inspection work should be undertaken considering that consultation to the residents about the damaged buildings will be made later.

History of the quick inspection of damaged buildings

○The history of measures taken for damaged buildings

When the Southern Italy Earthquake struck in 1980, quick inspection work was carried out very systematically. Then the Ministry of Construction of Japan (at present, the Ministry of Land, Infrastructure, and Transportation) started a project for comprehensive technology, the "project for advanced repair technology for earthquake damaged buildings" in 1981. The project developed a series of methods, from risk evaluation of damaged buildings to repair technology for wooden, steel and reinforced concrete buildings. When the Mexico Earthquake occurred in 1985, Japan used the quick inspection method for damaged reinforced concrete buildings as an international assistance and ensured its appropriateness. The U.S., well aware of the importance of quick inspection, compiled a manual of the postearthquake safety evaluation of buildings, "ATC-20" in 1989. Each municipality completed the system of safety evaluation. This manual worked very successfully in the Loma Prieta Earthquake and the Northridge Earthquake in the U.S. In Japan, after the project of comprehensive technology was undertaken, the Building Disaster Prevention Association of Japan published, "The standard of damage evaluation and the guidance of repair technology for the buildings hit by earthquakes" to publicize the result. After a technological standard was established, Shizuoka prefectural government established a quick inspection system of damaged buildings in 1991, followed by the Kanagawa prefectural government in 1992. When the Great Hanshin-Awaji Earthquake occurred in 1995, The quick inspection of damaged buildings was implemented for the first time in Japan. Then many other local governments established their own system. So far this system has shown great results in many earthquakes that have occurred all over Japan.

1980	Algeria Earthquake Southern Italy Earthquake	
1981		The Ministry of Construction of Japan started the project of comprehensive technology, "The project for advanced repair technology for earthquake damaged buildings" - for five years.
1985	Mexico Earthquake	The Ministry of Construction applied the draft of quick inspection method for damaged buildings, and ensured its appropriateness.
1986		The Ministry of Construction compiled "the manual of repair technology for damaged buildings" as the fruit of the project.
1989	Loma Prieta Earthquake in the U.S.A.	The U.S. compiled a manual of postearthquake safety evaluation of buildings, "ATC-20".
1991		"The standard of damage evaluation and the guidance of repair technology for the buildings hit by an earthquake" was published. *Each local government promoted the establishment of the quick inspection system.
1994	Northridge Earthquake in the U.S.A.	
1995	Great Hanshin-Awaji Earthquake (Earthquake in Southern Hyogo Prefecture)	The Ministry of Construction, local governments and private construction organizations cooperated with each other to implement the quick inspection of damaged buildings for the first time in Japan. The number of inspected buildings: 46,610 *Each prefectural government established and adopted the quick inspection system and the support system rapidly.
	Earthquake in Northern Niigata prefecture	The number of inspected buildings : 342
1996	Earthquake in Northern Miyagi prefecture	Council for Quick Inspection of Damaged Buildings in Japan was founded to create the support system and to standardize the inspection method. The number of inspected buildings : 169
1997	Satsuma Earthquake in Kagoshima	The number of inspected buildings : 2,048
1999	Akita Offing Earthquake	The number of inspected buildings : 9
2000	Earthquake in Western Tottori Prefecture	The number of inspected buildings : approx. 4,000
2001	Geiyo Earthquake	The number of inspected buildings : approx. 1,700